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The Distribution and Food of the Cormorant in Scottish Inland Waters

By D. H. MILLS, M.Sc., Ph.D.

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By D. H. MILLS, M.Sc., Ph.D.
Freshwater Fisheries Laboratory, Pitlochry

EDINBURGH: HER MAJESTY'S STATIONERY OFFICE
1965

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The Distribution and Food of the Cormorant in Scottish Inland Waters

INTRODUCTION

The common cormorant (*Phalacocorax carbo* L.)* is a large fish-eating bird with practically a world-wide distribution and, in the British Isles, normally frequents a marine habitat. Its presence on freshwater has raised fears for the future of fish stocks important to commercial and angling interests and, on little more than circumstantial evidence, the cormorant has been considered to be a serious predator of salmonid fish. Small numbers of cormorants shot in freshwater habitats have been examined and salmonid fish have been found in the stomach contents of birds from Scotland (Berry, 1936; Jones, 1959, and Meinertzhagen, 1959), England (Hartley, 1948) and Ireland (Piggins, 1959). Fears of the shag menace to salmonid fish stocks have also been expressed in New Zealand (Falla and Stokell, 1945), while in Russia the cormorant is considered a serious predator of freshwater fish (Sushkina, 1932, and Skokova, 1955). On the other hand Macan and Worthington (1951, pp. 176–7) state that the cormorant may be beneficial to the trout stocks in Windermere and Dickinson (1951) found only one trout in the 29 stomachs of the large black shag collected from Lake Taupo, a renowned trout lake in New Zealand and the Otago Acclimatisation Society are considering encouraging this bird so as to reduce the number of unwanted fish species in trout lakes (Black, 1964). In Australia, to judge by recent statements in the angling press (*Fisherman,* 1(1), 8–12 (1962)), the black shag is now considered to do little damage to important fish stocks.

This species is not protected in Great Britain under the Protection of Birds Act, 1954, and a reward is paid for this bird by River Boards in England and District Fishery Boards in Scotland. In many cases, these have been paid for many years but one or two District Fishery Boards, which became aware of the abuses arising from this practice, have discontinued paying rewards.

The purpose of this report is to assess the role of the cormorant as a predator of salmonid fish in the light of the inland distribution of this species and an examination of the stomach contents of cormorants shot on a number of Scottish inland waters.

* In Australia and New Zealand this species is known as the black shag and in Russia as the great shag.

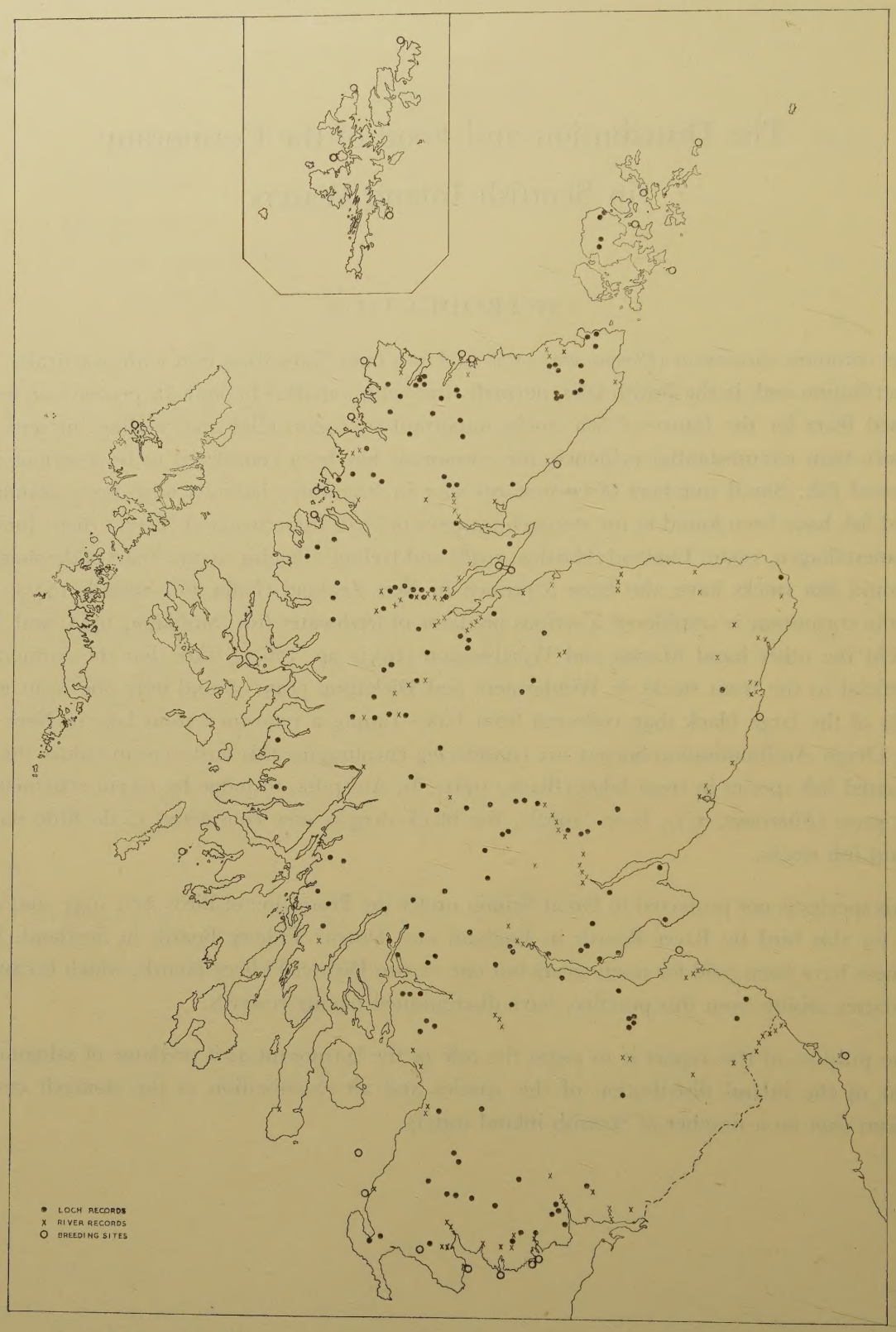

Fig. 1. Breeding sites and inland distribution of cormorants in Scotland.

DISTRIBUTION

(*a*) Breeding sites

The main breeding sites in Scotland are shown in Fig. 1. Other smaller sites, with one or two nesting pairs, are numerous but are not shown because records are probably incomplete, particularly for the west coast and the Inner and Outer Hebrides. Details of the largest nesting colonies are given in Table 1

TABLE 1

DETAILS OF THE MAIN BREEDING SITES OF CORMORANTS IN SCOTLAND

Site	No. breeding pairs	Authority
Loch Mochrum, Wigtown*	150–250	Baxter and Rintoul, 1953
Muckleroe, Shetland	240	Venables and Venables, 1955
The Ord, Caithness	100–200	Pennie (personal communication)
Castlecraig, Ross-shire	100–200	Mills (unpublished)
The Lamb, Firth of Forth	110	Smith, 1961
Ramna Stacks, Shetland	100	Venables and Venables, 1955
Summer Isles, Ross-shire	100	Darling, 1947
Cliffs of Orraland, Dumfries	100	Mayer-Gross (personal communication)

*The only inland nesting colony in Scotland.

A big nesting colony which should also be mentioned is that on the Farne Islands off the north-east coast of England with over 200 breeding pairs (Smith, 1961). Fisher and Lockley (1954, p. 205) state that there are no cormorant colonies in the British Isles with a thousand nests.

(*b*) Inland Distribution

(i) *Areas frequented*

The general inland distribution of cormorants in Scotland is shown in Fig. 1 and has been compiled from (*a*) personal observations; (*b*) observations made by regional representatives of the British Trust for Ornithology; (*c*) data from cormorant ringing recoveries kindly supplied by the Bird Ringing Committee of the British Trust for Ornithology and Dr. I. D. Pennie, and (*d*) published records (Baxter and Rintoul, 1953, etc.). These data cannot give a complete picture of the inland distribution as some areas are less well covered by observers. This is particularly true of the west coast and islands. However, it is considered that the overall picture is sufficiently complete for certain conclusions to be drawn.

Cormorants are widely distributed inland in Scotland. Baxter and Rintoul (1953) mention that they move up to 30 miles inland in the winter and may occur on waters up to 900 ft. above sea level. The present survey shows that these birds frequently occur as much as 40 miles inland, particularly during the winter and early spring. As can be seen in Fig. 1, cormorants occur on many inland lochs and are also found many miles up the rivers.

(ii) *Seasonal occurrence*

Though cormorants have been recorded on inland waters in every month of the year, they are most frequently seen during the winter and early spring, sometimes up to the end of May. In Sutherland (Pennie, personal communication) they occur in the largest numbers on the lochs during the winter. Mills (1964) records that most are seen on the Bran river system, Ross-shire in March, April and May.

Campbell (personal communication) states that, on the Tay system, they are chiefly seen during the winter and early spring, while in the south-west, Duncan (personal communication) mentions that they occur inland chiefly from the autumn to about mid-March.

Some idea of the time of year at which cormorants are most plentiful on inland waters can also be obtained from data on the numbers of birds shot on inland waters as revealed by ringing recoveries and the months in which birds were sent in for examination. This information is given in Table 2 which indicates that cormorants occur on freshwater most frequently between September and April.

TABLE 2

NUMBER OF CORMORANTS SHOT ON INLAND WATERS

Month	No. shot
January	22
February	24
March	12
April	33
May	11
June	6
July	1
August	2
September	29
October	21
November	18
December	20
Total	199

(iii) *Abundance*

In most inland areas of Scotland cormorants are usually seen singly or in parties of two or three but rarely more, although Baxter and Rintoul (1953) have recorded as many as 67 on St. Serf's Island in Loch Leven and Duncan (personal communication) states that there was a daily flight of 150–200 birds, in small flocks of about six, going up the River Nith at Dumfries during the winter of 1932–3 and that daily flights of this order are still to be seen on the Nith in winter.

The number of birds likely to come inland during the winter may depend to some extent on weather conditions and the availability of food at sea. In the Beauly and Inverness Firths, where there is a herring fishery between November and February, concentrations of up to 260 birds were recorded in December, 1962, but few were seen on the neighbouring rivers Beauly and Ness. During the early part of the winter of 1963–4 when the fishing appeared to be poor and the weather was mild many more birds were seen on the River Beauly. In the Firth of Forth, where there is a winter sprat fishery, concentrations of 300 to 400 have been recorded and 50 to 100 cormorants are recorded each winter in the Dornoch Firth, Montrose Basin and Firth of Tay. During the winter, birds may frequently feed in the firths and roost inland and birds have been shot flying up the lower reaches of the River Conon as they come in to roost.

(*c*) Movements

The movements of cormorants from their breeding sites in Scotland to other parts of the country are shown in Figs. 2–5. Though many of the ringed birds are recovered close to the ringing site a number

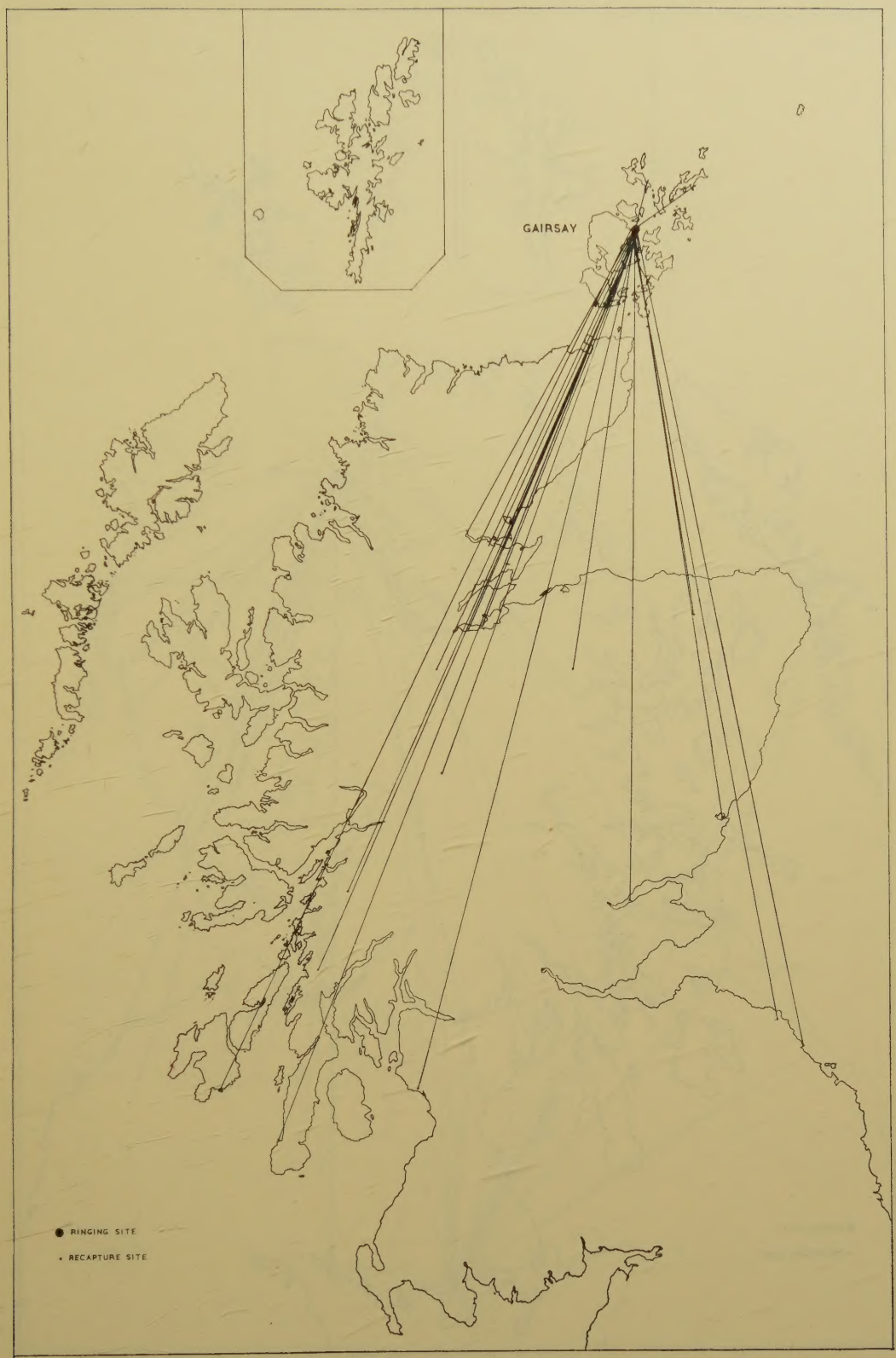

Fig. 2. Recaptures of cormorants ringed at Gairsay, Orkney.

Fig. 3. Recaptures of cormorants ringed at the Ord of Caithness.

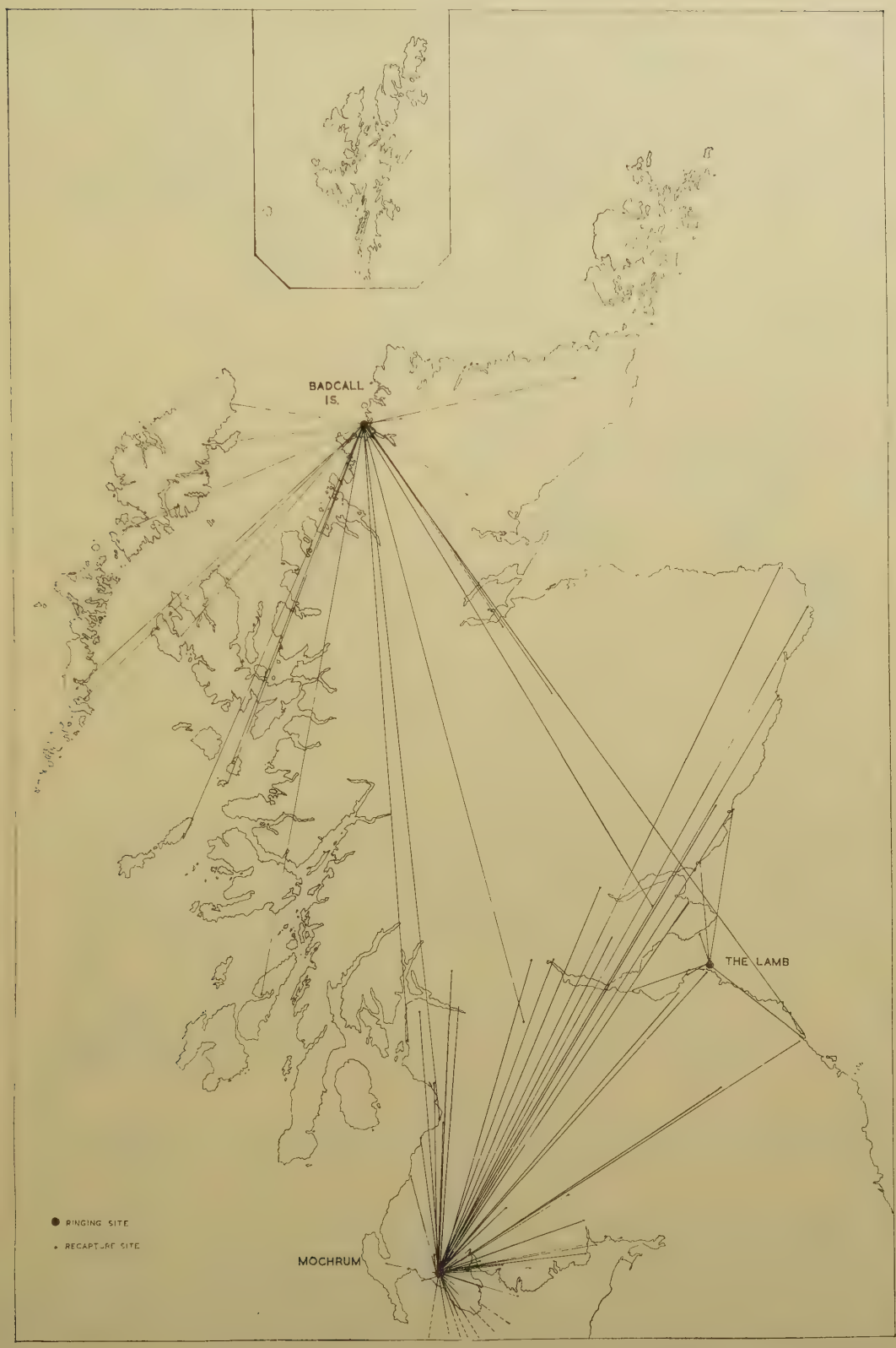

Fig. 4. Recaptures of cormorants ringed on the Badcall Islands, at The Lamb and at Mochrum.

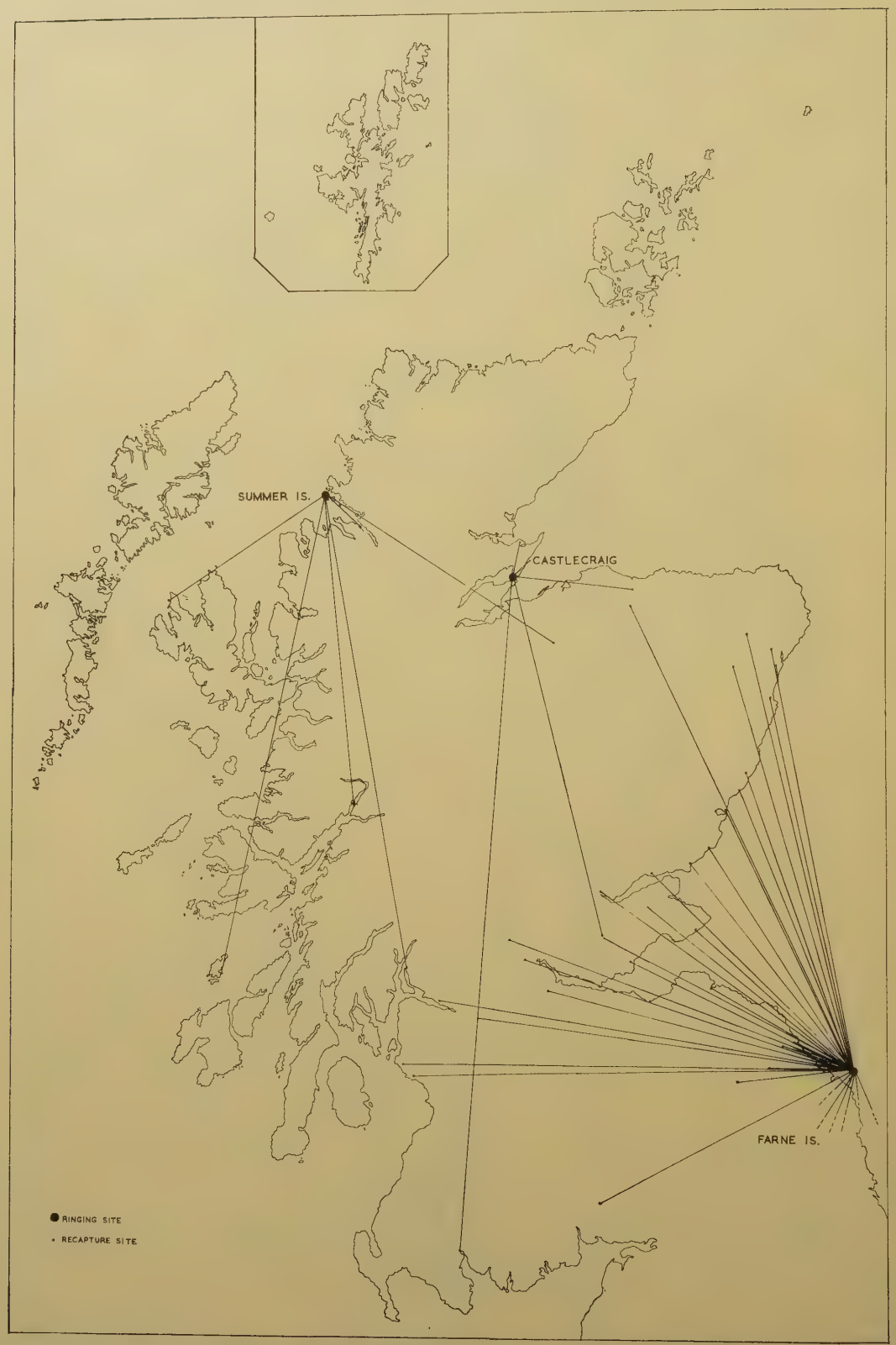

Fig. 5. Recaptures of cormorants ringed on the Summer Isles, on the Farne Islands and at Castlecraig.

are recaptured some distance away. Those marked in the north on the Orkney Isles, at the Ord, Caithness and on the Badcall Islands off the west coast of Sutherland have been taken as far south as the Tweed, and a bird ringed at Castlecraig in Easter Ross was recaptured at Creetown in the south west. Birds ringed in the south have shown a dispersal north as well as south (Figs. 2–4) and birds from Mochrum have been taken as far north as Fraserburgh on the north east coast while others ringed on the Farne Islands have been found at Methlick and Inverurie in Aberdeenshire. Some of the birds ringed in Scotland have been recaptured elsewhere and birds ringed in other parts of the British Isles have been recovered in Scotland. Details are given in Table 3 which shows the cormorant ringing recoveries for

TABLE 3

RECOVERIES OF RINGED CORMORANTS

Country in which ringed	Total no. recovered	Number recovered in: Scotland*	England	Wales	Ireland	France†	Spain	Portugal
Scotland	394	224 (56·9)	75 (19·0)	13 (3·3)	35 (8·9)	36 (9·1)	9 (2·3)	2 (0·5)
England	426	209 (49·0)	168 (39·4)	7 (0·7)	3 (0·7)	36 (8·5)	3 (0·7)	0
Wales	323	3 (0·9)	114 (35·3)	79 (24·4)	2 (0·6)	93 (28·8)	27 (8·4)	5 (1·6)
Ireland	238	7 (3·0)	17 (7·1)	3 (1·3)	171 (71·8)	31 (13·0)	6 (2·5)	3 (1·3)

Figures in brackets denote percentages.
*Including the River Tweed.
†Including the Channel Islands.

the period 1904 to 1961. It can be seen that 57% of the birds ringed in Scotland are recovered in that country. Almost 50% of the birds ringed in England are also recaptured in Scotland or the River Tweed district, but this latter result may well be a consequence of using an arbitrary geographical boundary, as one of the major ringing sites in England is the Farne islands, only a few miles south of the Scottish border. Very few of the birds ringed in Wales (1%) and Ireland (3%) have been recovered in Scotland.

FOOD

The methods of feeding of cormorants have been described by St. John (1882, p. 161), Steven (1933), Taverner (1934), Serventy (1938), Fisher and Lockley (1954, pp. 198–9), Meinertzhagen (1959, p. 52) and Skokova (1960).

In this investigation, a total of 129 stomachs from cormorants has been examined. Most of the birds were collected from the lochs, rivers and estuaries in the Conon Basin (65) and Ness river system (39). Smaller numbers were collected from lochs, rivers, estuaries and firths in other parts of Scotland. Of the 129 stomachs examined 44 were empty. The large number of empty stomachs is probably due to the regurgitation of food when the birds are shot and wounded. Details of the contents of the remaining 85 stomachs are given in Table 4. In 62 of the stomachs it was possible to count the number of fish eaten and these results are shown in Table 5.

TABLE 4

PERCENTAGE OF VARIOUS FOOD ORGANISMS IN THE STOMACHS OF CORMORANTS

Food organism	Percentage			
	Loch	River	Estuary and Firth	All areas
Brown trout (*Salmo trutta*)	42·8	22·6	—	24·7
Flounder (*Platichthys flesus*)	0	22·6	55·0	21·1
Salmon (*Salmo salar*)	19·0	17·0	9·0	16·4
Perch (*Perca fluviatilis*)	38·1	5·6	—	12·9
Eel (*Anguilla anguilla*)	9·5	13·2	9·0	10·5
Fish remains	4·7	11·3	—	8·2
Sea trout (*Salmo trutta*)	—	5·6	9·0	4·7
Gadus spp.	—	1·9	27·3	4·7
Three-spined stickleback (*Gastrosteus aculeatus*)	—	3·7	9·0	3·5
Pike (*Esox lucius*)	—	3·7	—	2·3
Clupea spp.	—	—	9·0	1·1
Crabs	—	—	9·0	1·1
Insects	4·7	—	—	1·1
Number of stomachs	21	53	11	85

TABLE 5

NUMBERS OF FISH EATEN BY CORMORANTS

Species	Numbers			
	Loch	River	Estuary and Firth	All areas
Three-spined stickleback (*Gastrosteus aculeatus*)	—	63 (46·7)	1 (5·5)	64 (33·7)
Salmon (*Salmo salar*)	11 (29·7)	23 (17·0)	6 (33·3)	40 (21·0)
Brown trout (*Salmo trutta*)	8 (21·6)	19 (14·0)	—	27 (14·2)
Perch (*Perca fluviatilis*)	12 (32·5)	5 (3·7)	—	17 (9·0)
Flounder (*Platichthys flesus*)	—	11 (8·2)	6 (33·3)	17 (9·0)
Eel (*Anguilla anguilla*)	6 (16·2)	8 (6·0)	—	14 (7·4)
Sea trout (*Salmo trutta*)	—	3 (2·2)	3 (16·6)	6 (3·0)
Gadus spp.	—	1 (0·7)	2 (11·3)	3 (1·6)
Pike (*Esox lucius*)	—	2 (1·5)	—	2 (1·1)
Number of stomachs	14	41	7	62

Figures in brackets indicate the percentage of the total numbers of fish found.

While feeding on lochs cormorants ate mainly brown trout, perch and young salmon; those feeding on rivers took chiefly brown trout, young salmon and eels, and birds shot on estuaries and firths were found to have been feeding on flounders, sea trout and gadoid and clupeoid fish. Piggins (1959) found that in Co. Mayo in Ireland cormorants on freshwater also fed on brown trout and eels. Lack (1945) states that eels are known to be a favourite food of cormorants while on freshwater. In the present investigation, while eels were taken frequently they were not taken as often as brown trout which were found to be taken more frequently than any other fish. The results given in Table 5 show that more

three-spined sticklebacks and young salmon were consumed than any other fish, but this observation tends to give a wrong impression as three-spined sticklebacks only occurred in two birds and the results in Tables 4 and 5 must be compared when assessing the diet of the cormorant. The comparison of the food of the cormorant and shag on Windermere by Hartley (1948) draws attention to this type of result and he states, 'It will be seen that assessment by occurrence tends to emphasise similarities in diet, a fact which is scarcely surprising when it is realised that the number of species of fish available is only nine . . . assessment by enumeration stresses the difference between the foods of the two species as a result of the small size of the sticklebacks (*Gasterosteus aculeatus*) which were the staple food of shags.' No sticklebacks were found in the stomachs of the 13 cormorants from Windermere. Perch were also found in cormorants shot on Windermere and Macan and Worthington (1951, pp. 176–7) consider that on this lake the cormorant is probably beneficial because it may keep the population of perch in check. The removal of brown trout from Scottish salmon rivers, and to some extent lochs, by the cormorant may benefit the young salmon stocks, as brown trout are known predators of young salmon (Piggins, 1959; Mills, 1964). In its consumption of pike, the cormorant is removing a predator. Nikolsky (1963, p. 134) also records pike in the diet (6·1%) of cormorants in the Volga delta.

Tables 4 and 5 also reveal the presence of flounders in cormorants shot on both rivers and estuaries and a gadoid fish in a bird shot on the river some eight miles from the sea. While flounders may occur in rivers some miles above tidal limits gadoid fish do not. The particular bird shot on the river which had a gadoid fish in its stomach had also taken a flounder, three salmon parr and a brown trout by 0930 hrs. on a morning in December (*i.e.* not more than an hour and a half after sunrise). This suggests the point, not often considered, that the presence of fish-eating birds on a river or loch does not necessarily mean that their whole meal has been taken at that site and that therefore calculations of the number of fish taken on an estimate of bird/days should be accepted with reservations in the case of what is primarily a marine bird. Many of those birds which had eaten flounders were shot as they flew up the River Conon in the evening to roost, again suggesting that conclusions should be drawn cautiously from an analysis of data on the food of marine birds shot on nearby lochs and rivers as, while they may have been shot on one of these habitats, they may not necessarily have been feeding there.

The size of fish found in the cormorant stomachs examined ranged from sticklebacks 5·0 cm. (2 in.) long to a brown trout 45·7 cm. (18 in.) long; other large fish taken include a sea trout of 40·6 cm. (16 in.) and an eel of 38·0 cm. (15 in.). The average length of brown trout eaten was 25·4 cm. (10 in.), the average length of perch eaten was 17·0 cm. (8 in.), while young salmon taken were on an average 12·6 cm. (5 in.) long with a length range of 8·0 to 15·5 cm. In a bird which weighs on average (based on 58 observations) 2·9 kg. (6½ lb.) it is not surprising that large fish are taken. St. John (1878, p. 157) refers to the large trout taken by cormorants and describes the throat of the cormorant stretching considerably and the mouth opening wide enough to swallow a 'good-sized' sea trout, and he also mentions their taking young waterfowl and rats. Martin (personal communication) observed cormorants on the west coast of Scotland taking young eider ducks. St. John (1882, p. 162) refers to a cormorant on the river Beauly taking a grilse kelt of 55·9 cm. (22 in.) and weighing 1·8 kg. (4 lb.) in January, 1850. The tail of the fish actually projected out of the mouth of the bird. In more recent years a similar observation was made on Loch Achonachie where a cormorant was seen carrying a grilse kelt to the shore. St. John (1882, p. 161) also records a cormorant swallowing a moorhen while Fisher and Lockley (1954, p. 199) record a kitten being found in the stomach of a cormorant.

The cormorant has no gizzard to assist in the breakdown of food as have the goosander and red-breasted merganser. Guy (1961) states that digestion is rapid, but van Dobben (1952), who carried out experiments on the rate of digestion, found, for example, that a 12-in. pike-perch (*Lucioperca sandra*) was digested in 15 hours. Guy (1961) quotes Ward, Robinson and Collinge as recording an average daily consumption of 15 lb. of fish, but more conservative estimates of the daily food consumption of the cormorant vary between 425 g. (15 oz.) and 700 g. (1 lb. 9 oz.) (Sushkina, 1932; Macan and Worthington, 1951, pp. 176–7, van Dobben, 1952, and Skokova, 1955, 1963). Results from the present study show that as much as 1 kg. of fish may be present in the stomach, though normally the weight of fish present is about 700 g. Meinertzhagen (1959, p. 52) states that cormorants will eat 17% of their body weight daily, which

gives a value of 500 g. Sushkina (1932) has estimated that cormorants kill 5000 metric tons of fish annually in the North Caspian Sea, which is 1·5% of the total commercial catch. Because of the number of errors involved no calculation of the numbers of trout and young salmon taken annually by a cormorant has been attempted.

PARASITES

A number of parasites were found in the stomachs of the cormorants examined. These included the nematode *Contracaecum spiculigerum*, which was present in all stomachs examined, and the tapeworms *Schistocephalus solidus* of which the intermediate host is the three-spined stickleback and *Ligula intestinalis* which has as its intermediate host a number of species of freshwater fish including the roach (*Rutilus rutilus*).

DISCUSSION

Although the numbers of cormorants examined is much larger than those examined previously by other workers in the British Isles the present data on the food of the cormorant on freshwater are still not sufficiently complete to allow any firm conclusions to be drawn concerning the effects of the cormorant on salmonid fish stocks.

In assessing the importance of the cormorant as a predator of salmonid fish, particularly salmon, it is useful to compare their food with that of other fish-eating birds occurring on freshwater. Mills (1962) found that the percentage occurrence of young salmon was much higher in the goosander (*Mergus merganser*) and the red-breasted merganser (*M. serrator*) (57·2% and 42·5% respectively). Elson (1962) states that the high percentage of young salmon in the diet of the American merganser (*M. merganser americanus*) is due to the high forage ratio (Hess and Swartz, 1941) or availability factor (Allen, 1942) of salmon in the environment frequented by this bird. This might explain the difference in the percentage occurrence of salmon in the goosander and red-breasted merganser and cormorant as the former two birds both tend to feed, while on freshwater, in fast-running and comparatively shallow water, whereas the cormorant usually fishes in the large, deep pools of the river. Young salmon are usually found in the former environment and when disturbed generally dart for cover. This will make them less available to cormorants, but not to goosanders and red-breasted mergansers which have bills adapted for probing bottom crevices and seizing fish (Lindroth and Bergstrom, 1959). Because the average size of trout taken by cormorants is 10 in. (with fish of up to 18 in. ($2\frac{1}{2}$ lb.) being taken) the presence of cormorants may affect angling interests, though the extent of this effect will depend on the numbers of cormorants present and the amount of time they frequent the area.

It is perhaps also necessary to take into consideration possible secondary effects through altering established biological relationships among several associated species. Cormorants also eat some fish which prey on salmon, so that control of the cormorants would tend to increase these predators. Elson (1962) studied the effect of the removal of mergansers on the various fishes associated with salmon in the Pollett River. He found that the one abundant salmon-eating fish, the eel, increased as much as or even more than the salmon but, nevertheless, the production of salmon smolts increased. A similar situation might apply following cormorant control.

Information on the diet of cormorants on estuaries is limited. Although young salmon and sea trout were found in the stomachs of cormorants shot in estuaries these fish may not necessarily have been taken from that habitat. Rae (personal communication) found that, out of 50 cormorants examined from or near the estuary of the Aberdeenshire Dee, mainly during April and May, over the years 1957–63, only three were found to be feeding on smolts. A detailed examination of more stomachs of cormorants from estuarine waters is needed before any conclusions on cormorant predation on salmonid fish, particularly sea trout, in that habitat can be drawn.

It is concluded that the cormorant is not a serious predator of young salmon as it eats this species far less frequently than the goosander which was found to be a serious predator only when present above a density of 1 bird per 55 acres. Further, the cormorant usually occurs in small numbers on freshwater in Scotland and generally for only part of the year. The effects of predation by cormorants are likely to be most obvious to the brown trout fisherman, because these birds feed on trout of catchable size. Where the number of cormorants on trout fisheries are high control may be beneficial but more information is required on population densities of cormorants before the population density likely to have serious effects on the fish population can be determined. Black (1964) draws attention to the fact that on hill lochs, where trout may be small and numerous, the presence of cormorants might result in an improvement in the size and quality of the trout by reducing the population.

It is suggested that bounty payments should be discontinued because they lead to abuses, for example, one District Fishery Board in Scotland ceased paying rewards for cormorants' beaks as many handed in were from birds shot along the coast and at sea and not from inland waters at all; from data abstracted from 344 cormorant ringing recoveries from Scotland it was found that only 28·0% of the birds shot were killed on inland waters. Steven (1933) has also drawn attention to the doubts raised about the efficiency of a bounty scheme for the destruction of cormorants and shags round the shores of Cornwall.

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SUMMARY

1. The main breeding sites of cormorants in Scotland are listed.
2. Cormorants have been recorded throughout Scotland on lochs and rivers many miles inland where they are present, in small numbers, mainly from September to April.
3. Ringing recoveries show that some birds may be recovered some distance from their breeding sites. Most of the birds ringed in Scotland and England were recovered in Scotland, but very few of the birds ringed in Wales and Ireland were recovered in Scotland.
4. Examination of the contents of 129 cormorant stomachs from Scottish inland waters reveals that cormorants fishing on lochs feed on brown trout, perch and young salmon in that order. Cormorants fishing on rivers feed most often on brown trout, young salmon and eels. They also feed on three-spined sticklebacks, flounders, pike and sea trout. Brown trout of up to 2½ lb. were recorded from cormorant stomachs.
5. It is considered that cormorant predation on salmonid fish stocks is most likely to affect the brown trout population and because of the size of the brown trout eaten, this predation affects the catchable stock of brown trout.
6. Information on the diet of cormorants on estuaries is limited and a more detailed study is necessary before any conclusions can be drawn.
7. It is concluded that the cormorant is not a serious predator of young salmon. However, because predation affects the catchable stock of brown trout, control may be beneficial where cormorant numbers on trout lochs are high. Bounty payments are considered to be valueless.

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